

Reply to Catherine Sefton

This paper makes a valuable contribution to the study of the hydrology of intermittent rivers and ephemeral streams. In particular, it is the first time observations of river flow and groundwater level have been used in combination with observations of hydrological state in a regionalisation approach, marking a step forward in the modelling and mapping of intermittency at national scale.

The ONDE dataset is unique in the literature, notably the large number of sites, the coverage of headwater streams and the national extent, but has limitations in the summer-only timing and small number of observations. The merging of the “no visible flow” status with the “dried out” status means that a key benefit of the dataset is not utilised, as the two-status classification of flowing and drying that remains is no advantage over that available from gauged river flow data. Discussion of the network would benefit from broader contextual comment on the contribution and application of these data.

The paper is well written and referenced and is recommended for final publication with minor revisions.

The authors would like to thank Catherine Sefton for her positive evaluation of our paper and the specific comments and text/figure corrections that will lead to improve the manuscript. The detailed answers to the specific comments are presented below.

Specific comments

Given the small number of observations at each site, the claim that the ONDE dataset offers more accurate assessment of inter-annual variability than the gauging station network (L376-377) needs further justification. Conversely, the claim that the dataset makes it possible to capture drying events at the regional scale (L381-382) would benefit from stressing the monitoring of both upstream and downstream drying – uniquely each with national extent – in your approach.

With this statement, the authors wanted to highlight the added information provided by the ONDE network in comparison with the HYDRO database. The location of these observation sites on headwater streams is more adapted to identify IRES along the river network (about 2 400 ONDE sites have a drainage area < 50 km² against 850 gauging stations in the HYDRO database). Despite the limited number of observations available at each ONDE site, the regional approach developed here has succeeded in reconstructing drying dynamics at the daily time step and this reconstruction allows thereafter examining the inter-annual variability of drying occurrence. This study cannot be performed at the regional scale using the set of gauging stations due to the low proportion of gauged head streams in the HYDRO database.

In section 3.1.2, the drying detection by the ONDE network is compared to HYDRO database. In Table 1, we show that the frequency of drying for IRES available in the HYDRO database does not vary much from one year to another (about 30% whether in wet year or in dry year). This variability seems low compared to the drying frequencies observed each year with the ONDE network (Fig. 4b and

Fig. 5). To illustrate this, we added above the figure of the distribution of the percentages of drying observed at gauging stations from HYDRO database for each year following the same symbology than the figure 5 in the manuscript. The percentages of drying are very similar during wet years (2013, 2014) and dry years (2012, 2015, 2016). In that sense, we wanted to underline the interest of using the ONDE network to improve our knowledge on the temporal pattern of the frequency of drying.

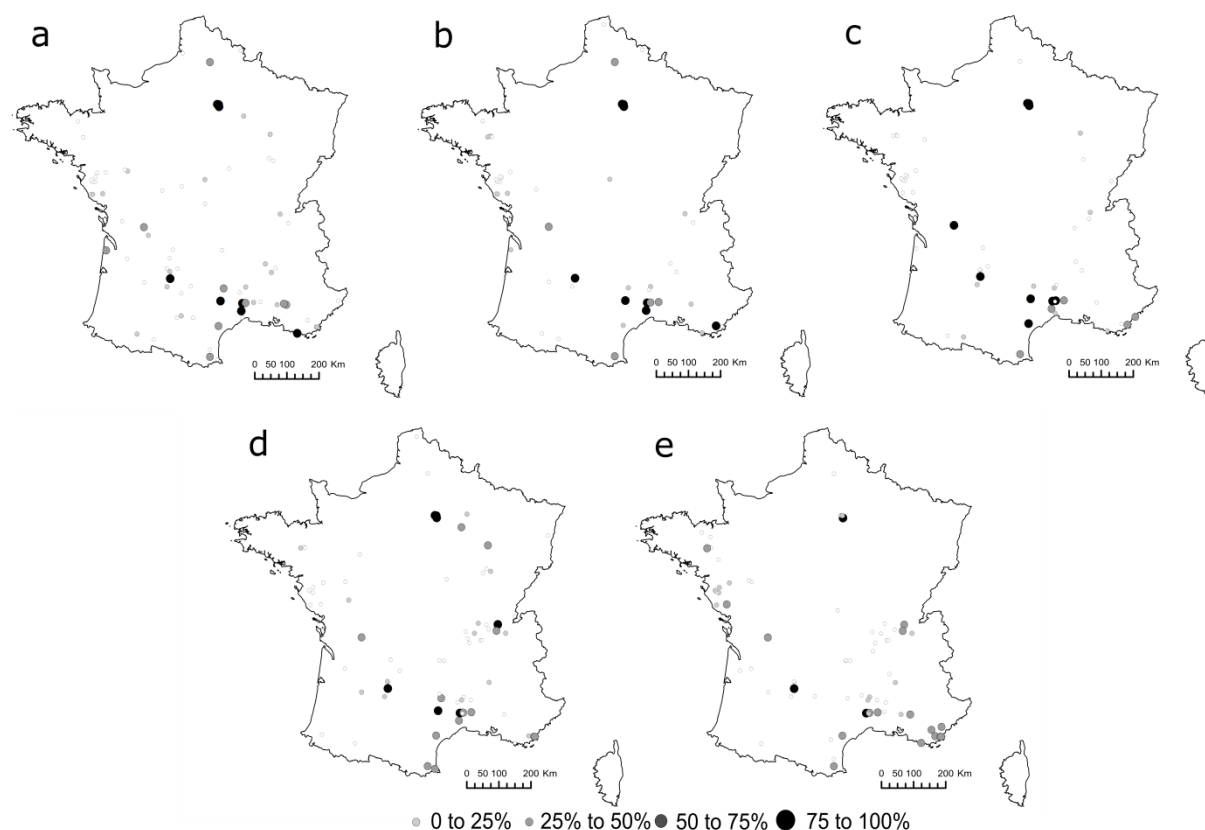


Figure 1bis. Distribution of the percentages of drying observed at gauging stations HYDRO for the years: (a) 2012, (b) 2013, (c) 2014, (d) 2015, and (e) 2016.

Estimates are only valid at the regional scale. Unfortunately the approach is unable to provide information about how the dry events develop in space (patch connectivity). The method does not use any information about upstream-downstream dependencies that would be required for example for mapping purposes.

The presentation of summer-only status data as “% drying” needs qualification, as it suggests assumptions about the status in the rest of the year. In particular, clarification would be helpful in line 242, when the context implies it means the number of sites with at least one drying each year (as in line 241), rather than the % of all observations at all sites (as in Fig 4).

We modified these sentences in the revised paper (Lines 271-275 and Lines 443-447).

The first sentence presents the number of sites where, at least, one drying event is observed over the period 2012-2016, to identify the headwater streams in the ONDE network that can be considered as

IRES. At the end of the first paragraph of section 3.3.1, the proportion of drying over France was computed as the total number of drying observed with the ONDE network over France divided by the total number of ONDE observations available during the same year (Fig. 4a).

The technique of constructing mean non-exceedance frequency from river flows and groundwater level is attractive and robust. However, its limitation in this regional approach of failing to capture the effect of local rainfall should be commented upon, especially given the dominance of rainfall-driven intermittency stated in section 3.3.2.

This is discussed in the revised paper (Lines 475-481).

The factors involved in the in-situ drying dynamics are numerous. Rainfall is one of these factors and has a significant effect on the re-wetted streams during rainfall convective episodes. The authors agree that the mean non-exceedance frequency is a global index that only captures the hydrological conditions at the regional scale in modelling the RPoD. However we may expect that for rainfall-driven river flow regime, the effect of rainfall events on flow intermittence at the HER2-HR scale is contained in the daily discharges and groundwater levels used to the mean non-exceedance frequency and that the effect of rain on the proportion of drying is indirectly taken into account.

In the case of a local rainfall event that affects an ungauged basin, we may miss key information to simulate the possible end of the drought of the affected region. This is one of the limits of the regional approach.

The frequency of drying from gauging station data needs to be defined (line 272). Context suggests it is flow permanence (dry days or dry months per time period), but frequency in intermittent rivers and ephemeral streams can also mean dry spells per time period, and it also needs to be clear and justified whether it's calculated from daily means or monthly means.

Indeed the sentence is confusing. The frequency of drying described here corresponds to the ratio between the number of dry days and the total number of days between the 1st May and the 30th September of one year ($273-121+1=153$ days).

In section 3.2.1., the difference in performance between the two explanatory hydrological datasets is attributed to the difference in the number of gauging stations and piezometers. The pattern in Figure 8 is not as clear as the text suggests, and it would be good to comment also on the assumption of stationarity and how it might vary between HER2-HR combinations. Similarly, historical reconstructions make assumptions about stationarity that need to be acknowledged.

The question on stationarity arises due to uncomplete information about the applications to the two datasets. Models are calibrated against observation available during the same period (i.e. 2012-2016). However the selected piezometers and gauging stations differ according to the dataset resulting in different time series of mean non exceedance frequency representative of the period

2012-2016. Thus there are two sets of parameters specific to each dataset (see section 2.4 and 2.5) for both LLR and LR models.

We revised the description of the applications (Lines 258-260).

The conclusion is a good summary of the results but would benefit from contextual comment, both with respect to the stated objective of this paper and more broadly on the contribution being made to the field.

We modified the conclusion in the revised paper in order to highlight the contribution of our study (Lines 544-551).

Textual and Figure corrections:

Thank you for your very attentive reading, all your corrections/suggestion will be taken into account.

Figure 3, step 1 : It is unclear why HR1, 4 and 6 are shown as types of monitoring site, when section 2.1 has defined them as types of hydrological regime.

HR means “hydrological regime” and the figure 3 shows one HER2 (HER2 n°97) which contains streams which have 3 types of hydrological regime (HR1, HR4 and HR6). For the example shown on the figure, all ONDE sites located on streams with a HR with a type 6 are selected in order to make the regression. We clarified this aspect on a revised Figure 3.

Figure 10: This would benefit from additional plots for a year that has good NSE, as the text is comparing years as well as model performance.

We added additional plots of the year 2012 which obtain the better NSE during the calibration period and we added observations vs. predictions of the full year 2017 in a revised Figure 10. The section 3.2.3 and the Table 2 have been revised in order to present these new results.